TRANSPORT AND LONG-TERM SUSTAINABILITY: A DISCUSSION ON INTERGENERATIONAL JUSTICE

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ABSTRACT

The long-term effects of transport policy options, such as candidate new infrastructure projects, have hardly any impact on the results of a Cost-Benefit Analysis (CBA) due to discounting (expressing future costs and benefits in current currency, using an interest rate decreasing their value). Nevertheless, such impacts are relevant from the perspective of intergenerational justice. Making use of ethical theories this paper discusses intergenerational justice of transport focusing on climate change, energy use, and infrastructure. The paper is not a plea to stop discounting. As far as discounting preferences from a consumers' perspective are concerned, there is a very strong case for it. The paper provides some first ideas on solutions for the ignorance about the interests of future generations.
Keywords: sustainability, ethics, intergenerational justice, Cost-Benefit Analysis

1. INTRODUCTION

Transport policy decision, certainly infrastructure decisions, have long lasting impacts on society. New rail roads, roads, ports and airports often last over more than 100 years, although they may be modified and components are replaced.

When considering the pros and cons of different future transport policies, including infrastructure decisions, the options need to be evaluated *ex ante*. Many countries use a Cost-Benefit Analysis (CBA) for such an evaluation (e.g. Thomopoulos and Grand-Muller, 2013). However, in a CBA the time horizon generally is limited to a few decades, and future costs and benefits are discounted, which results in the benefits and costs that occur after several decades, say 30 years, having hardly any impact on the outcomes. As a result of thie limited time horizon and discounting therefore, the long-term impacts of transport, relevant for future generations, are very difficult to deal with in CBA, despite the fact that they are often considered to have important ethical dimensions. Discounting allows one to express future benefits and costs in the currency of a base year. People value a certain amount of

money now higher than the same amount of money in, say, 5 years, even if inflation would be corrected for. One of several reason is that banks generally offers interest rates higher than inflation, increasing the value of money. A discount rate of 3% means that, after correction for inflation, 100 euros now is valued equally high as 103 euros after one year. Note that the reason for discounting generally is a pragmatic one, not a moral one (Birnbacher, 2006).

Discounting is criticized because it underestimates the importance of future generations (e.g. Bromley, 1989; Gardiner, 2006; Pearce et al., 2006; Portney and Weynant, 1999; Koopmans, 2010). Besides this, even if discounting was not a problem there is still the question of what is fair in terms of how much infrastructure of which quality we should leave for future generations.

This paper discusses the intergenerational justice of transport infrastructure policies. The aim is not to come to 'clear cut solutions' (though some ideas for solutions are included) but to make the reader aware of the importance of intergenerational justice aspects of transport infrastructure policies. A point of departure is that from an intergenerational perspective long-term impacts certainly matter. In this paper 'long-term' is indicatively defined as: over 30 years, up to at least 100 years. For transport these impacts relate to (at least) infrastructure, energy use and climate change – the areas which this paper discusses.

Section 2 discusses the relevance of the intergenerational justice of transport infrastructure, energy use and climate change. Section 3 explains the concept of intergenerational justice. Sections 4-6 discuss how to deal with intergenerational justice for non-renewable resources such as fossil fuels, climate change and infrastructure respectively. Section 7 finally summarizes the most important conclusions and discusses these findings.

2. RELEVANCE OF INTERGENERATIONAL JUSTICE FOR TRANSPORT INFRASTRUCTURE AND ENERGY USE / CLIMATE CHANGE

Transport infrastructure

Because of seven reasons discussed below, an important question is: how can such long-term issues be dealt with when decisions are made about building transport infrastructure? One might argue that maybe in the future the importance of infrastructure might decrease, making the intergenerational dimension of infrastructure less relevant. For example because travel might be substituted by ICT. However, so far travel time budgets have been remarkably stable (e.g. Mokhtarian and Chen, 2004). Consequently, from an intergenerational perspective it seems plausible to assume that future generations might spend as much time travelling as we do today. The main message of this section, therefore, is that the heritage of transport infrastructure is very relevant from an intergenerational perspective. Below I explain why.

I first explain what transport infrastructure includes: it includes the physical infrastructures, such as roads and railroads. These infrastructures not only include the direct surface-related hardware (and in the case of the electrified railways also the electricity supply), but also hardware related to management and safety. One can think of signals for rail infrastructure, dynamic signals for route guidance on roads, and ICT systems for air traffic management. Of

course the long lasting surface-related hardware is of most importance from a long term perspective.

From an intergenerational perspective it is important that what we leave for future generations not only relates to non-renewable resources, but also to man-made resources, such as buildings and infrastructures for transport, electricity, and water. Each generation born inherits a certain level of infrastructure from previous generations, which is often still extremely useful. An important question is: Why is transport infrastructure important from an intergenerational perspective? There are at least seven reasons. A first *potential* reason is that in many countries most – if not all – much transport infrastructure is in public hands, at least most roads and railroads. This is not to suggest that privately owned heritage is not relevant from an intergenerational perspective, but if the public sector is highly involved, one could argue that it is even more important to include intergenerational issues in case of the *ex ante* evaluation of policy options, because it makes policy makers responsible (see for several related discussion chapters in Button and Hensher (2005).
A second reason is that transport infrastructure is strongly related to basic values, in particular the freedom to move (see Van Wee, 2011). Probably such values should be safeguarded for future generations. Thirdly, adequate transport infrastructure is of crucial importance for societies, both from an economic perspective, as well as from the wider societal perspective. Fourthly, transport infrastructure is very expensive. The construction of motorways and railroads in densely populated countries and regions is extremely resource consuming. For example, Campos and De Rus (2009) compared the construction costs of 24 high-speed rail projects in operation worldwide, and found that the costs per km range from 9 – 39 million Euros, with an average of 18 million Euro. Urban rail projects are in general even more expensive. Flyvbjerg *et al.* (2008) compared per kilometre costs of 17 European projects. They conclude that these costs vary greatly, from 16 to 330 million US$[i] per kilometre.

Fifthly, as already explained in the introduction, transport infrastructure lasts for a very long time, at least in the sense of the land take and the impacts of transport on the wider society, but also often the infrastructure itself. This applies to roads, railways, harbours, airports, and metro systems. Many rail lines that western countries nowadays operate were constructed in the nineteenth century. Most motorways in western countries were built more than three decades ago, often much longer (e.g. Filarski and Mom, 2011). Not only does infrastructure last a long time but changing infrastructure also takes a lot of time. This relates to the infrastructures themselves, as well as to related land-use impacts. Due to the high construction costs, transport infrastructure networks have very high levels of sunk costs (costs which have already been incurred and cannot be recovered) (Button, 2010), leading to relatively slow dynamics. Building new transport infrastructures in densely populated regions is very complex because of the (lack of) availability of land and the impacts on the environment. This complexity also results in relatively slow dynamics, both with respect to the introduction of new types of infrastructure (in the past centuries: rail lines, roads), as well as with respect to changes in the networks of a specific type of infrastructure. To make it even more complex, land-use changes have an impact on transport and vice versa, as conceptualized in so-called Land Use–Transport Interaction models (LUTI models – see below). These interrelations mean that changes in infrastructures lead to changes in land-use patterns (e.g. Geurs and Van Wee, 2004). To summarize, transport infrastructure can easily have an impact on society for at least a century.

Sixthly, transport, more than any other dominant sector, relies heavily on fossil fuels, mainly oil Davis, 2010). Consequently, we consume non-renewable resources, and therefore may leave future generations with fewer possibilities to fulfil their needs (see below). Choices with respect to infrastructures therefore may have an impact on the use of non-renewable resources and dependency on oil for a long time. Seventhly, building transport infrastructure

often has long term negative implications on communities and nature. These relate to the landscape, but also to barrier effects for people and animals (e.g. Alexander and Waters, 2000). If species cannot survive, this may affect ecosystems.

Energy and climate change

Because energy use and climate change are closely related, I will discuss energy use and climate change together. The intergenerational aspect of energy use relates to the availability of non-renewable (fossil) energy, and raises the question of how much should be left for future generations or which level of use is acceptable from an intergenerational perspective. The intergenerational aspect of CO_2 relates to the question of what is an acceptable level of greenhouse gases (GHG) emissions and the related climate change. This question is a general one, not specifically linked to transport. This paper does not discuss the *general* ethical issue of climate change. What could specifically be important for the link between climate change and energy use on the one hand, and transport on the other, is firstly that within the transport sector CO_2 emissions and energy use are increasing rapidly, more than in any other large sector (like industry, the electricity production, agriculture) (OECD/IEA, 2009). Secondly, transport may also in the future, more than other sectors, rely on fossil fuels. For example, bio-fuels could be produced, but if so, using them as input for electricity production may be more cost-effective than using the same inputs to produce bio-fuels for the transport system. Electricity could firstly become an option for cars, maybe in the longer term for lorries and buses, but it is out of the question for aircraft, barges and sea going ships. Thus the transport sector is vulnerable to the depletion of fossil fuels, 'peak oil' or unstable production and the export of oil. Thirdly, transport, probably more than any other category of consumption, allows us to consume energy and emit GHG in large quantities in a short period of time, flying being the most extreme option. On a fully occupied (all seats) Boeing 747-300 intercontinental flight of 10,000 km taking 10 hours, about 325 litres of jet fuel is needed to transport one passenger (calculations based on figures derived from http://en.wikipedia.org/wiki/Boeing_747).

3. THE CONCEPT OF INTERGENERATIONAL JUSTICE – AN OVERVIEW

Introduction

Until 1980 intergenerational justice, especially related to negative impacts of activities of the current generation, hardly received any attention from philosophers, the reason being that the impact of human beings on the planet was relatively limited (or not recognized) for a long time (Tremmel, 2006). A key difference between intergenerational justice and other forms of justice is its unidirectional dimension: future generations depend on the actions of the current generation, not vice versa. In this way future generations are vulnerable.

Intergenerational justice can be made specific by defining (1) the period of time to be considered, (2) the question of who to consider, (3) the question of what it exists for (content – the six forms of capital. The six forms of capital include natural capital, artificial and financial capital (financial capital also includes intergenerational debt), cultural capital, social capital, structural capital (formal and informal rules and institutions), and human capital (Tremmel, 2006; Wallack, 2006).), (4) the question of significance of responsibility for the future, compared with the responsibility for the present.
It could be a problem to motivate people to accept responsibility for the future (Birnbacher, 2006). Thus, even when intergenerational justice is made explicit, and people are motivated to accept responsibility for the future, it is very difficult to apply it in practice. This is mainly

because of the high level of uncertainty about the future (e.g. Davidson, 2009), examples being the number of people (e.g. Arrhenius, 2009), their incomes (or better: quality of life), preferences of people in the future (Bykvist, 2009), availability of natural resources and substitutes for their current use (which are partly related to the uncertainties with respect to knowledge), and finally the future quality of nature. All such uncertainties are not only problematic because of the uncertainties themselves (what will be the developments in these areas), but also because of uncertainties about how to deal with them. To illustrate: let us assume there is no uncertainty about the size of the future population (over time), and we are sure that the world population will double in, say, 50 years. Should the rights to non-renewables then be distributed equally over generations (regardless of their size) or do their sizes count? e.g. Gosseries (2001; cited in Steiner and Vallentyne, 2009) states differences in population size do not matter, Steiner and Vallentyne conclude they do: it is people who matter, not groups of people: all people have equal rights, not al *groups of* people.

In this section, I will discuss intergenerational justice from the position of *ex ante* evaluations of transport projects and policies. For general discussions I refer to two books, the Handbook of Intergenerational Justice, edited by Tremmel (2006) and the book Intergenerational Justice, edited by Gosseries and Heyer (2009). The point is that intergenerational justice may very well exist, and that if it does, the conventional method for including long-term effects in CBAs of transport projects and policies, needs to be considered, and could even be flawed.

Which theories should be used for questions regarding intergenerational justice?

Assuming intergenerational justice exists, and should be included in the *ex ante* evaluation of long-term policies (transport and other polices), an important question could be: which theories to use? First of all, it is important to understand that not all ethical theories are equally useful.

An influential ethical theory is utilitarianism. Utilitarianism is a theory within the wider family of consequentialism. Consequentialism 'is the view that normative properties depend only on consequences' (Stanford Encyclopedia of Philosophy). Utilitarianism, more specifically, 'is the claim that an act is morally right if and only if that act maximizes the good, that is if, and only if the total amount of good for all minus the total amount of bad for all, is greater than this net amount for any incompatible act available to the agent on that occasion' (Stanford Encyclopedia of Philosophy). Utilitarianism provides an ethical foundation for CBA: a CBA compares policy options from the perspective of utility (mainly based on the Willingness To Pay of consumers). The principal problem of applying utilitarianism to intergenerational justice is not the concept of utility, but the practice (or maybe even need) to discount, reducing the utility of future generations to almost zero.

Another important ethical theory is contractarianism. The idea of contractarianism is that 'whether an action is right or wrong depends on whether it accords with or violates principles that would be the object of an agreement, contract or choice made under certain conditions by members of the moral community' (Darwall, p. 21). 'The moral theory of contractarianism claims that moral norms derive their normative force from the idea of contract or mutual agreement' (Stanford Encyclopedia of Philosophy). Contractarian theories have the problem that contracts between generations – and certainly those who do not overlap – cannot be signed, and cooperation between generations is not possible. Therefore contractarianism is often considered to be of not much help in the study intergenerational justice.

Most theoretical literature on intergenerational justice is based on deontology and more specifically on (egalitarian) theories on justice. 'The word deontology derives from the Greek words for duty (deon) and science (or study) of (logos). In contemporary moral philosophy,

deontology is one of those kinds of normative theories regarding which choices are morally required, forbidden or permitted. In other words, deontology falls within the domain of moral theories that guide and assess the choices we make in what we ought to do (deontic theories)' (Stanford Encyclopedia of Philosophy). Consequently, it is not the outcomes that matter, nor the virtues of persons. Deontology rejects the idea that there is an overarching principle (such as utility) that could be used for integration (and thus evaluation) or prioritization. The twentieth-century English moral philosophers W.D. Ross (cited in Morton, 2007, p. 12-13) developed a common-sense ethical theory referred to as 'intuitionism' based on eight obligations: (1) Keep promises, (2) Act justly, (3) Express gratitude for services rendered, (4) Do good deeds towards others, (5) Avoid injuring others, (6) Make reparations for wrongdoing, (7) Avoid lying, (8) Improve oneself

These theories will be used in the discussion on how to deal with intergenerational justice in sections 4-6.

4. HOW TO DEAL WITH INTERGENERATIONAL JUSTICE? THE CASE OF NON-RENEWABLE RESOURCES

As explained above one important aspect of intergenerational justice and transport is the use of non-renewable resources. This includes energy (fossil fuels) and raw materials. Accepting that intergenerational justice exists, the next question then becomes: how to deal with it? This question is of relevance for the overall use of non-renewable resources, not only for its use by the transport sector.

Many philosophers refer to the Rawls' Theory of Justice (Rawls, 1971) and applications of his theory to intergenerational justice. Rawls introduced the concept of the 'veil of ignorance'.

> "To insure impartiality of judgment, the parties are deprived of all knowledge of their personal characteristics and social and historical circumstances. They do know of certain fundamental interests they all have, plus general facts about psychology, economics, biology, and other social and natural sciences. The parties in the original position are presented with a list of the main conceptions of justice drawn from the tradition of social and political philosophy, and are assigned the task of choosing from among these alternatives the conception of justice that best advances their interests in establishing conditions that enable them to effectively pursue their final ends and fundamental interests" (Stanford Encyclopedia of Philosophy).
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> "Suppose parties do not know to which generation they belong (…). Thus the persons (…) are to ask themselves how much they would be willing to save at each stage on the assumption that all other generations are to save at the same rates. (…). In effect then they must choose a just saving principle that assigns an appropriate rate of accumulation to each level of advance" (Rawls, 1971: 287, quoted in Wolf, 2003; see also Wallack, 2006; Attas, 2009; Heyd, 2009).

Later, Rawls argued that parties that should make choices that are relevant from an intergenerational point of view, should understand that they are choosing that principle they would have wanted earlier generations to have adopted (Wolf, 2003). Wolf discusses the theory of Rawls in the context of climate change related intergenerational justice, emphasizing that the theory of Rawls was developed to be applied within a nation, whereas climate change is global.

Accepting the guiding principle of 'just saving rates', the next question then is: Which saving rate? Or maybe better: which principle for setting the saving rate? In ethical literature, many discussions on the 'right saving rate' can be found (see for example Attas, 2009, Heyd, 2009). Wolf (2003) argues that one category of setting saving rates could be based on the idea that sustainability is reached when we use resources at exactly the same rate at which we either replace them, or develop economic substitutes for them. The depletion of fossil fuels could be an example: if we could develop ways (technologies, institutions) to produce renewable energy sources (e.g. wind, solar, hydro-thermal based) in substantive quantities for prices comparable to, or lower than, oil based energy, then the depletion of oil would be less problematic. This, however, does not cover the issue that oil is a raw material for many more products, such as plastics, but it does tackle the energy content of oil and intergenerational issues.

In setting the 'just' saving rate several ingredients are relevant (e.g. Wolf, 2003). Important ingredients are, firstly, the population size, since it may change, having implications for the question of whether it is an absolute or relative saving level that matters, in relation to population size (see also section 3). This subject is discussed in the ethical literature by many authors (see, for example, Gosseries, 2001; 2009; Parfit, 1984; Arrhenius, 2009). Another ingredient is the availability of alternatives. One can think of alternatives for fossil. Thirdly, some goods are non-tradable, such as specific nature areas. The saving rate discussion therefore probably does not apply to such goods. Fourthly, maybe human well-being is more important than the level of resources or opportunities. Accordingly, the concept of 'stable welfare' could be attractive, either at a total level (the sum of all individuals) or at the average level (the sum divided by the number of people). However, focusing on the average welfare may be problematic, since it ignores distributional issues, and so the distribution of welfare needs to be included in the analysis as well. Another problem with (average) welfare is that welfare and well-being are not the same. Fifthly, we need to know what future generations will need, appreciate, value etc. which is inherently problematic

Although several philosophers have argued that contractarianism is not the best theory to discuss intergenerational justice, because contracts between generations cannot be signed (see above), the Rawls based idea of intergenerational justice can solve the 'contract problem' – it is based on the contractarian tradition in political philosophy: If people were able to design contracts with other generations, what would the contract look like? But the idea of intergenerational justice can also be legitimated by utilitarianism. If we accepted that there is no reason to assume that human beings of the current generation are worth more than people belonging to future generations, and we want to maximize utility from an intergenerational perspective, it implies that we should include in the equation the utility of future generations[ii]. A major problem then relates to discounting: it is not clear if we should discount the options of future generations to meet their needs. And if yes, there are good reasons to no treat all needs in an equal way – some (basic) needs, such as the freedom to move, are probably more important than some luxury needs, such as expensive cruises.

A next question is: *what* needs to be sustained? In line with the discussion on the difference between welfare and wellbeing, one could question the relevance of a certain level of resources. Sen (2009: 250) discusses this issue: sustaining living standards is not the same as sustaining people's freedom and capability to have what they value. Thus an important question to be answered is: What should be sustained? I would argue that welfare can be used as a first indicator for wellbeing, freedom, and capabilities. But because welfare is not the perfect indicator, I would also recommend an explicit check on the plausibility of using welfare in the specific case where a choice needs to be made.

Utilitarianism generally ignores distribution effects. But these can be important. If they are brought into the discussion another important choice is that between an egalitarian position

or a sufficientarian position. Whereas egalitarianism focuses on (reducing) differences between people or population groups, sufficientarianism assumes that everybody should be well-off up to a certain minimum threshold which is 'sufficient' for their needs. The choice between egalitarianism and sufficientarianism relates to the question of whether we should focus on the differences between generations (the egalitarian position) or on the minimum levels of goods or satisfying the needs of future generations (a position based on sufficientarianism).

A final remark on intergenerational justice and saving rates: most literature on this subject implicitly or explicitly assumes that future generations will (in terms of income or welfare) be better off than the current generation. An increase in incomes may well occur, but does not necessarily have to be the case. If we look at history, and fluctuations of wealth over time (expressed in terms of centuries) and place, several examples of decreases in welfare can be found. If we discuss intergenerational justice from the perspective of natural resources, the time frame easily can be as long as a couple of hundred years. And within such a time frame decreases in welfare can occur.

5. HOW TO DEAL WITH INTERGENERATIONAL JUSTICE? THE CASE OF CLIMATE CHANGE

A special case of intergenerational justice relates to climate change. Again, this discussion is a general discussion, not related only to the transport sectors emissions of GHG, but because of the high share of transport in GHG emissions, it is very relevant for the *ex ante* evaluation of transport projects and policies.

It is highly likely that climate change due to human activities already occurs (see, amongst others, the reports of the Intergovernmental Panel on Climate Change – IPCC) and will continue to occur in the long run (from now until more than a century from now), making it an intergenerational ethical issue. Hood (2003) states that 'climate change raises issues of equity and justice because it is expected that climate change will not affect all people or all countries the same' (Hood, 2003: 679). 'The same' firstly applies to measures to reduce emissions: from an equity point of view one could argue that some nations should take more action to prevent greenhouse gas (GHG) emissions than others: countries that already emit a lot of GHG emissions should also reduce such emissions disproportionately. Another aspect of 'the same' is the distribution of the burden of climate change. A utilitarian approach, which assumes that utility is maximised, could lead to outcomes other than minimizing the impact on the least fortunate. This does not only apply to the distributional question of which nation should reduce GHG to what extent (and when), but also to the overall level of the reduction of GHG emissions compared to a non-interventionist policy. Let us assume that the world has a dictator that can decide the future level of GHG emissions. If she had a utilitarian approach to ethics, based on a worldwide willingness to pay (WTP) for the reduced risks resulting from climate change (such as the risk of flooding), she would value the benefits of reducing GHG emissions, such as reducing flooding risks in Bangladesh, much lower than if she supported an ethical approach based on minimizing the negative impact on the least fortunate. This is due to the fact that WTP for risk reductions of the Bangladeshi people is very low because of the low income level in that country. Note that it is highly questionable whether it is ethically sound to apply the WTP approach to value human lives across world regions and over time.

Not only do the costs of measures and the distribution of the burden differ across countries (and probably even within countries) and world regions, but there is also the distribution over generations: the current generation might implement measures to reduce GHG emissions,

and future generations might benefit from these measures. This formulation suggests that emitting GHG emissions is a 'right'. One could also argue: the current generation emits GHG whereas future generations suffer from climate change. Both positions raise the question of how future generations should be valued compared to the current generation. Some philosophers think we should care more about the current generation or those who live close to us in time, than about those who live in the more distant future, just because of their temporal distance from us. This position is called 'pure discounting' (Broome, 2008). An opposing view is that we should be temporally impartial. In that case discounting is not done (at least not for the reason of valuing less those who live in the more distant future). This is the view of, amongst others, Broome (2008). We discuss discounting in the next section.

The discussion is further complicated by technological changes. It would be too simple to say that all people, regardless of the generation to which they belong, have equal rights to non-renewables, such as oil. This is because (future) technology might allow future generations to 'do more' with the same quantity of oil (e.g. Steiner and Vallentyne, 2009) – see also the different categories of capital as listed in the introduction to this section.

The contributions to the debate on intergenerational justice of Rawls and Sen (see section 4) do also apply to climate change, and will not be repeated here.

In addition to these ethical considerations, there is a consideration that is both relevant from an ethical perspective, as well as from a more traditional economic perspective: the risk of catastrophe. There is a chance that temperature will rise much more than the average projections of the IPCC. If the temperature rises by more than eight degrees Celsius (the chances according to most studies being about 5% - Broome, 2008), the disruption could pose some risk of a devastating collapse of the human population, perhaps even to extinction. Any such event would be so bad that even multiplied by its small chance of occurrence, its severity could dominate all calculations of the harm that climate change will cause (Broome, 2008). Such a calculation would result, from a purely economic perspective, in very high values for the reductions of GHG emissions. In addition, it would raise very serious, but very difficult, ethical questions.

Linking intergenerational justice to the climate change policy debate it is important to realize that this debate is relatively recent – only since the Kyoto protocol of 1997 countries have targets.

6. HOW TO DEAL WITH INTERGENERATIONAL JUSTICE? THE CASE OF INFRASTRUCTURE

Contrary to the use of fossil energy and climate change, the discussion on transport infrastructure is transport specific, although several aspects are also relevant for other infrastructures, such as electricity infrastructure.

The first issue I will discuss here is the issue of the value of infrastructure for future generations. It is of course very difficult to assess this value. This is firstly because we, as explained above, are uncertain about future population size: the larger the population, the more people might benefit from infrastructure that the current generation leaves for the next generations. Secondly, we do not know what the transport needs of future generations might be. An assumption of stable needs in the 1950s – translated in terms of infrastructure use per capita – over, say, five decades, would have significantly underestimated the value of airports or motorways, because nowadays people fly much more often than 50 years ago. On the other hand, it would have overestimated the value of canals, because of the mode

shift from barge to roads. It is quite common to consider a period of only a few decades in *ex ante* evaluations such as Cost-Benefit Analysis. However, using longer periods in a CBA – 50 years for example – does not seem to hold any value as any benefits would be discounted over that many years (see above). This leads to an important question: What is the best way to deal with the estimation of the future value of infrastructure and discounting? A possible solution might be to do what-if analyses. The 'what' relates to the impact of the answers of the questions to the impact on the outcomes of ex ante evaluations. Examples could include: what if future generations would value infrastructure that we decide upon today equally to the current generation (in absolute or relative (to income) terms, per person or in total)? What if the value increased in accordance with the discount rate as assumed? If only the time horizon of a CBA would be relevant the answers to such question can relatively easily be explored via sensitivity analyses varying discount rates. Providing answers covering a much longer time horizon is much more cumbersome and would need the development of dedicated methodologies – it is beyond the scope of this paper to discuss such methods. Nevertheless some indicative ideas are presented but not specified in detail. For example, we could base such what-if questions on analyses of the historical value of infrastructures. A second solution might be to think of changes in infrastructure and its use over longer periods. More specifically one could explore how long infrastructures have been in use (and to what level) in the past. Many railway lines built in the 1850s are still in use, but horse tram lines from about a century ago are not. If infrastructure is not in use anymore, it can or cannot become useless. Horse trams were replaced by electrical trams, and therefore most of the investments in infrastructure were still of value. What are the implications for motorways and other roads, that in most countries are the most capital-intensive category of infrastructure (total volume of sunk costs)? If the current generation of road vehicles were to become obsolete, it is important to explore what types of vehicles would replace them. Automated guided vehicles (AGVs), for example, would still need motorways, although extensions to increase capacity would probably not have much value, because in the case of AGVs the capacity of motorways will increase multiple times. Airports are an infrastructure category that is even more difficult to value. On the one hand forecasts under Business as Usual scenarios suggest aircraft forecasts exceed any other transport forecast (e.g. WBCSD, 2004; Schafer *et al.*, 2009). On the other hand, if we run out of oil, or were to implement strict climate policies, air transport would probably be the most vulnerable transport category (Gilbert and Perl, 2008).

Another important question is: what quality and quantity of transport infrastructure should be left for future generations? In addition, how should quantity and quality be expressed? With respect to quality, one could argue that the infrastructure should on average be at a constant (and adequate) level of maintenance. This does not apply to each individual part of the infrastructure, but at the network level. However, the 'constant level of maintenance' assumption can also be criticized. For example, future generations might have better technologies or more money to maintain roads. If so, a future lower level of maintenance could be less problematic and less costly to improve. Another argument for criticism might be related to changes in vehicle characteristics and the use of infrastructure. It could be relevant if future vehicles are to be able to be driven faster. Trains driven at 200 km/h require 'smoother' rail lines. Should the current generation therefore leave rail infrastructure in a 'smoother' state than it inherited it from the previous generation? On the other hand, if in the future cars were to have a better chassis, maybe less 'smooth' roads would result in the same level of driving comfort. It is also important to note that nowadays almost all western countries have speed limits on motorways. In this case, maybe we should not leave motorways in a 'better' condition than needed in order to drive comfortably at the maximum speeds allowed. Because of such uncertainties I think that the 'constant level of maintenance' assumption could be a starting point for discussion, but that there are also good reasons for not including this assumption.

The quantity of infrastructure to be left for future generations is probably even more difficult to address. A first question is: which quantity? Is it an absolute quantity, e.g. the number of kilometres of motorways or motorway lanes in a given country? How then to deal with changes in population size (see above)? Do they matter? The probable answer is 'yes'. Assuming an increase in population size and higher incomes one could argue that in the future there will be more people who can cover the costs of infrastructure and they will be richer, reducing the quantity of infrastructure the current generation needs to leave for future generations. On the other hand, if there will be more people, each with equal rights compared to the current generation, maybe more infrastructure needs to be left for future generations.

As explained above technological change may also be relevant. What if, for example, in twenty years time road vehicle technologies allow us to drive at short headways, greatly increasing the capacity of motorways? As a consequence, extensions to the motorway network that are considered necessary now might not be in the future. Or what if a specific infrastructure type becomes obsolete? Leaving large quantities of infrastructure for future generations might even be valued negatively, for example because it could be a barrier and dismantling would cost money, or because it has a negative impact on the landscape or nature. To summarize, it is extremely complex to make an ethical judgment on the quantity of infrastructure that we should leave for future generations.

The main conclusion of the discussion above is that the current practice of discounting is called into question, as it seems unclear whether this practice correctly expresses the intergenerational dimension in infrastructure.

7. CONCLUSIONS AND DISCUSSION

The most important conclusions of this paper are summarized below:.

- The most important subjects for discussion from an intergenerational perspective of transport are probably infrastructure, the use of fossil fuels and other non renewable resources, and climate change.
- The ethical aspects of transport infrastructure include (1) that it is related to the large impact of the public sector, (2) that it is relevant for basic values, for example the freedom to move, (3) that adequate transport infrastructure is of crucial importance for societies, both from an economic perspective as well as from the wider societal perspective, (4) that transport infrastructure is very expensive, (5) that transport infrastructure lasts for a very long time, (6) that transport, more than any other dominant sector, relies heavily on fossil fuels, mainly oil. Choices with respect to infrastructures therefore may have an impact on the use of non-renewable resources and dependency on oil for a long time. (7) That building transport infrastructure often has long term negative implications for communities and nature.
- Rawls thinks intergenerational justice exists when the parties that make choices make those choices based on the principles they would have wanted earlier generations to have adopted. The perspective of Rawls on intergenerational justice is based on the contractarian tradition in political philosophy. Ideas of Rawls and Sen can lead to other conclusions than those of utilitarian philosophers.
- Setting saving rates for non-renewable resources, including fossil fuels, is very difficult, for many reasons. Firstly it is questionable whether it is reserves that matter, or opportunities for activities that result from the use of non-renewable resources, introducing the relevance of alternatives. Secondly, changes in population size could matter. Thirdly, savings rates probably do not apply to non-tradeable resources such

as nature areas. Fourthly, distributional aspects matter. Fifthly, we do not know what future generations will need, appreciate, value etc.

- An important question is: how to deal with the estimation of the future value of infrastructure and discounting? A possible solution might be to do what-if analyses. Examples could include: what if future generations valued infrastructure that we decide upon today equally to the current generation (in absolute or relative (to income) terms, per person or in total)? What if the value increased according to the discount rate as is assumed?
- The 'constant level of maintenance' assumption is a first point of departure when considering what the quality of infrastructure to be left for future generations should be. The quantity of infrastructure to be left for future generations is very difficult to assess, firstly because we are uncertain about future population size. Secondly, because we do not know what the transport needs of future generations might be. Thirdly, incomes of future generations matter, and fourthly, the availability of technology matters.
- In the *ex ante* assessment of transport policy options, including infrastructure, the issue of non-renewable resources (including the use of fossil fuels) is poorly addressed. This concerns the attention that is paid to the subject in itself (as a problem to be reduced), the selection of alternatives for a policy problem or challenge, and the estimation of pros and cons of options. Nevertheless, long-term impacts can be very relevant from the perspective of intergenerational justice.

Discussion

These conclusions are not a plea to stop discounting. I think certainly as far as discounting preferences from a consumers' perspective are concerned, there is a very strong case for it. But what can we do about the resulting ignorance about the interests of future generations? One way to deal with it is to not discount for climate change or human lives, for example. Another way is to assume an increase in the value, the price tag, to be put on, for example, GHG emissions, the value of a human life, or nature. Increasing such values using a higher interest rate than the discount rate increases future benefits to infinity, assuming an unlimited time horizon. In my opinion it is defendable to increase the values of at least some items (CO_2 emissions, nature, lives) that are relevant from an intergeneration perspective, e.g. with the same percentage as the discount rate, not discount them, or apply lower discount rates than usual. An economic reason for increasing discount rates is that the environment is considered to be a 'luxury good': the more people earn, the more they are willing to pay for quality aspects, including a better environment (Baumol and Oates, 1988). In addition, as incomes increase the quality of the environment often decreases, which could induce an additional price increase (Hoel and Steiner, 2007; Sterner and Persson, 2008). A very clear difference between current practice and using lower discount rates that would result, is that using lower discount rates would make GHG emissions count much more than is currently the case in CBAs. The influential Stern report (Stern, 2006) shows that applying low discount rates would make a strong case for policies that result in strong emissions of greenhouse gasses. In addition, I think not discounting or increasing values is more relevant for GHG emissions and the depletion of fossil fuels and raw materials. Fossil fuels and raw materials can probably, to some extent, be replaced. The value of infrastructure to a large extent is comparable to the value of many consumer goods and services, and could therefore be discounted, at least if the quality of infrastructure exceeds a certain minimum level that is needed from a sufficientarian point of view (see section 4).

A final but very important question is whether the transport sector should be treated separately from the wider society. There are both practical and theoretical reasons to answer the question both positively or negatively. It is beyond the aims of this paper to discuss this subject. The main message is that the discussion on intergenerational justice is very relevant

for the transport sector, but almost absent in current practice with respect to ex ante evaluations of transport policy options.

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[i] Currencies are as presented in the paper. The euro-dollar exchange rates have varied significantly over the period of time of construction of the infrastructure lines that are included in the range as presented. Using, for example, the current exchange (dollar-euro) rate would therefore be misleading.

[ii] Nevertheless, utilitarianism is criticized because it fails to deal with the problem of intergenerational justice (e.g. Wallack, 2006). In my opinion these critics relate to the way utilitarianism has often dealt with the subject of discounting, but they do not convincingly show that utilitarianism per definition is incapable of dealing with intergenerational justice.